Ecosystems & Ecophysiology – Lecture 1

Introduction to aquatic systems

Ecosystems & Ecophysiology course deals with the interactions between organisms and the physical environment. Two halves, ecology and physiology.

Ecology – The study of biophysical, biochemical, and physiological processes used by animals to cope with factors of their physical environment, or employed during ecological interactions with other organisms (animal).

The ecosystem is all living communities (**biotic**) and their associated non-living (**a biotic**) environmental components in a defined area.

Individuals of the same species = POPULATION,

POPULATION + Populations of other species = COMMUNITY,

COMMUNITY + non-living part of the environment = ECOSYSTEM

Physiology – study of the functioning of organisms – **how they work**.
Ecophysiology– function in relation to particular environments or niches
Or Examines how the physiological functions of organisms influence the way they interact with the environment, both biotic and a biotic.

The natural environment in which organisms live has two components:

1. **A biotic** – characterized by physical and chemical factors – i.e. temperature, rainfall, pressure, Ph, water, light &wind, Climate.

2. **Biotic** – all living organisms, which interact with each other– i.e. Competition & predation.

Niche- the range of environmental factors over which an individual can have positive fitness" (for an organism/species). Describes the environmental factors to which an organism has adapted.

Niches have two components: The **ABIOTIC** component& The **BIOTIC** component.

Focus on aquatic ecosystems, both marine (sw) & freshwater (fw). These combine a high level of diversity but with common features based on the physical properties of water.

Aquatic Animal Ecophysiology- The relationships between important environmental parameters and the physiology of aquatic animals.

Water

A water molecule is made up of one atom of oxygen and two atoms of hydrogen. Water molecules are not charged, but the oxygen atom has a stronger attraction for electrons of the molecule than the two hydrogen atoms, so the oxygen atom carries a partial negative charge and the hydrogen atoms carry a partial positive charge on each water molecule. The unequal charge distribution on a water molecule makes it **polar.** The polarity causes the partially positive regions of water molecules to be attracted to the partially negative regions of other of other water molecules, giving water an unusually ordered structure for a liquid and a unique set of chemical characteristics.

Water is fundamental for existence of animals and plants. Water is an excellent **solvent** (liquid capable of dissolving or dispersing other substances). The substances that become dissolved in water include **mineral ions, sugars (mainly glucose), amino acids** etc. Water is vital for the survival of all organisms and always has been an important drink to humans.

Water Properties: According to the various physico-chemical properties, water possesses several distinct characteristics:

Chemical Properties of Water.

1.Buffer: A solution that resist any change in pH when small amounts of acid or base are added; i.e. **a weak acid** or **Base**.

2.Gases dissolved in water. **Seawater** at 0°C may contain 50% more dissolved gasses (e.g. O2) than Seawater at 20°C. **Freshwater**, which is less dense than seawater, can hold an even larger amount of dissolved gases.

3.Hardness: The quality of water produced by soluble salts of calcium ions (Ca2+), magnesium ions (Mg2+), or other alkaline earth substances. Hardness commonly is expressed in terms of mg CaCO3.

4.PH (**potential hydrogen**): In general, the lower the pH the more heavy metals can be dissolved from the substrate into the solution.
5.Trace Elements: The growth of a plant is dependent upon the amount of trace elements presented to it in minimum quantities; e.g. **CO2, PO43-, NH4+, SO42-**, etc.

Physical properties of Water

1.Absorption of Light: Certain surfaces and colors absorb the visible spectrum of light. Water easily absorbs the UV-spectrum (**wavelengths <350nm**) and the IR-spectrum (**wavelengths >800nm**).
2.Density: Ratio of the mass to its volume : Density of water is temperature dependent in that it increases with higher levels of salinity and is heaviest at a temperature of 4°. Density is a critical factor for aquatic. Freshwater is less dense than seawater.
3.Specific Heat Capacity: The quantity of heat per unit mass required to raise the temperature by 1°C; a body of freshwater can store more heat than a body of seawater; consequently temperature extremes are less likely to occur in freshwater lakes.
4.Black Body: A body that absorbs all the radiation incident upon it (eye). Good absorbers (bad reflectors) are also good emitters; e.g. the sun. A black pot filled with hot water looses heat faster than a white pot.
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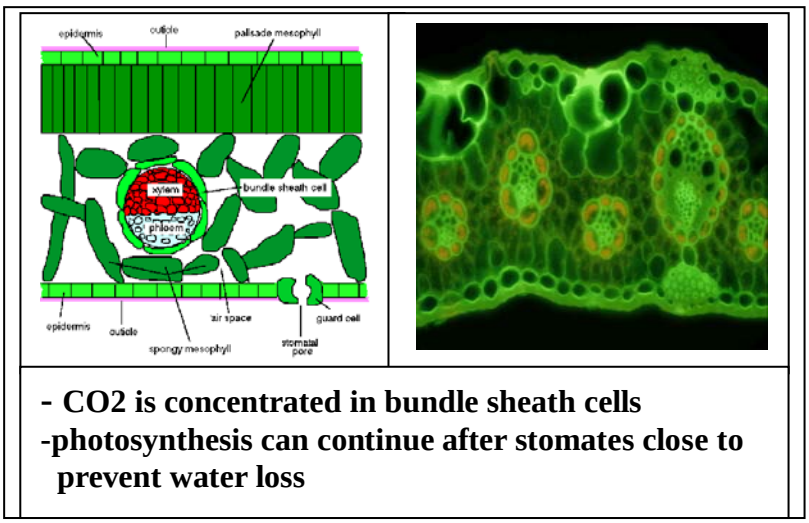
Water Bodies : Differentiation among bodies of water regarding to their flow characteristics.

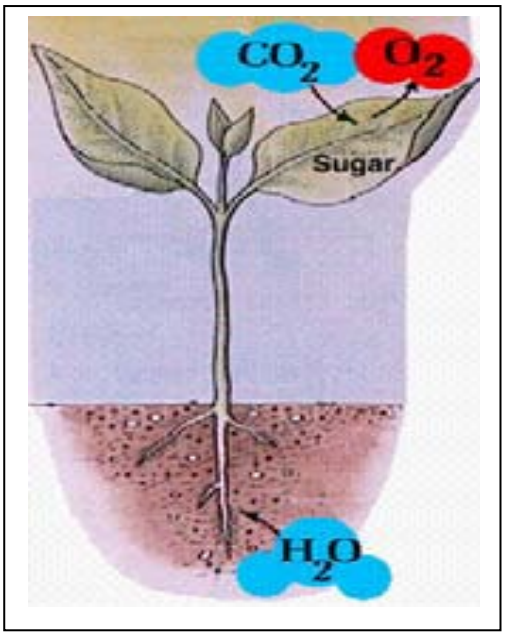
- **Groundwater**: The water below the surface.
- **Lentic Waters**: Also called lentic environments, characterizes a relatively still water of a lake which do evolve periodic wave action.
- **Lotic Waters**: Characterization of a flowing river or stream with a typically aperiodic wave pattern (current, circulation, etc.).

Energy sources

Photosynthesis: Needs light & CO_2, plus nitrate & phosphate for protein synthesis. CO_2 is not usually limiting in aquatic systems.



- CO2 is concentrated in bundle sheath cells
-photosynthesis can continue after stomates close to prevent water loss



Six molecules of water plus six molecules of carbon dioxide produce one molecule of sugar plus six molecules of oxygen

Light is always less available in water than in the air above. 20-98.5% of light is reflected from the surface, depending on the angle of incidence. Much reflected at low angles. The rest is absorbed or scattered by the water, dissolved organic matter & particles, or by Organisms themselves. In water with dense algal bloom light may penetrate only a few cm. Animals use light as cue, plants use sunlight to make their own food.

Food web

The food web is made up of organisms at different levels of feeding, known as:
TROPHIC LEVELS:

* **primary producers** - organisms that can perform photosynthesis.
* **primary consumers** - organisms that eat primary producers.
* **secondary consumers** - organisms that eat primary consumers.
* **tertiary consumers** - organisms that eat secondary consumers.
* **quaternary consumers** - organisms that eat tertiary consumers

DECOMPOSERS are a special type of consumer that can eat dead, organic matter (Detritus) and convert it back into its inorganic components.

We also can categorize animals on the basis of food type they eat:

* **Herbivore** - animal that eats plant matter.
* **Carnivore** - animal that eats meat.
* **Omnivore** - animal that eats a variety of things (plant and animal).
  But don't forget...
* **detritivore** - eats dead, organic matter (detritus), but does not decompose it.
* **insectivore** - eats insects.
* **frugivore** - eats fruits.

Herbivores

- The critical link to plants
- Most herbivores lack enzymes to digest cellulose.
- Rely on mutualistic bacteria and protozoans in gut.

Carnivores

- Not restricted to animals (e.g., pitcher plants)
- Easy transition for animals (prey are high in N)
- Simple guts

Omnivore
Silver carp, zooplankton, phytoplankton, detritus.

Detritivores

- Same challenges as herbivores (lots of C, little N).
- Tricky - some may be deriving most energy from the microbes on the decaying organic matter (OM) not the OM itself.